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AN ESTIMATE OF PARTICLE FLUX FROM PIONEER 8 AND 9

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1. Introduction

Five years of particle impact data obtained from Pioneer 8 and 9 have established reliable frequency levels for the nearecliptic region covered. This analysis is concerned with obtaining a multiplier which permits an estimate of the particle flux through a 1-A.U. sphere centered at the sun.

2. Assumptions

The estimate obtained is based on the following assumptions.

(a) The particle distribution is independent of longitude.

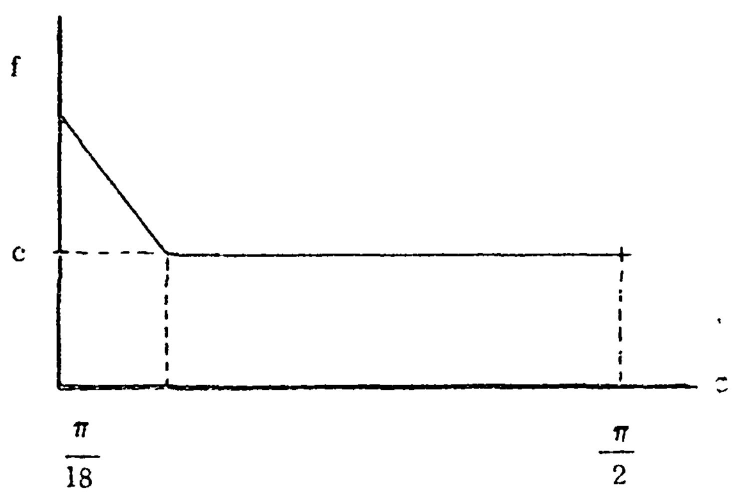
(b) About 27% of all the particles are found between the latitudes of $\pm 10^\circ$. (Reference 1)

(c) The density is assumed symmetric in the latitude linear between $\pm 10^\circ$ and constant outside this interval.

3. Analysis

The assumptions in (2) lead to the following formula of the particle density function.

$$(1) \qquad f(\phi, \lambda) = \begin{cases} c + m\left(|\phi| - \frac{\pi}{18}\right) & |\phi| \le \frac{\pi}{18} \\ c & |\phi| > \frac{\pi}{18} \end{cases}$$



As a density function it must satisfy.

$$(2) \quad \frac{1}{4\pi} \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \int_{-\pi}^{\pi} f(\phi, \lambda) \cos \phi \, d\lambda \, d\phi = 1$$

Since 27% of all particles are concentrated between $\pm$ 10° latitude

$$(3) \quad \frac{1}{4\pi} \int_{-\frac{\pi}{18}}^{\frac{\pi}{18}} \int_{-\pi}^{\pi} f(\varphi, \lambda) \cos \phi \, d\lambda \, d\phi = .27$$

Equations (2) and (3) permit computation of constants c and m in equation (1). Simple algebra permits reduction of (2) and (3) to the system

$$(2c) \quad \int_{\frac{\pi}{18}}^{\frac{\pi}{2}} f(\phi, \lambda) \cos \phi \, d\phi = .73$$

$$(3c) \quad \int_{0}^{\frac{\pi}{18}} f(\phi, \lambda) \cos \phi \, d\phi = .27$$

The constants c , m are found to be

$$(4) \quad \begin{cases} c = .883 \\ m = -7.68 \end{cases}$$

$$f(0, \lambda) = c - \frac{\pi m}{18} = 2.22$$

The angle subtended by the Pioneer collector is given by β. The fraction of the particles encountered by this collector is then given by·

$$\int_{-\frac{\beta}{2}}^{\frac{\beta}{2}} \int_{-\frac{\beta}{2}}^{\frac{\beta}{2}} f(\phi, \lambda) \cos \phi \, d\phi \, d\lambda$$

This angle is so small that the integrand may be taken as constant and the integral reduces to $\beta^2 f(0, \lambda)$

The total particle flux is therefore given by·

$\dfrac{n}{\beta^2 f(0, \lambda)}$ where n is the number of particles incident in unit time,

and the mass flux $\dfrac{M}{\beta^2 f(0, \lambda)}$ where $M = n \overline{M}$

$\overline{M}$ the mean particle mass.

For the dimensions of the experiment .1 x .1 meters the multiplier becomes:

$$\beta \simeq \frac{0.1}{2.346 \times 6.378 \times 10^{10}} = .0067 \times 10^{-10} = 6.7 \times 10^{-13}$$

$$f(0, \lambda) = 2.22$$

$$\frac{1}{\beta^2 f(0, \lambda)} = .01003 \times 10^{+26} = 1.0 \times 10^{24}$$

References:

1. Symposium on meteor orbits and dust, p. 74.